Classification of Igneous Rocks: Diorite vs. Syenite – a suggestion to avoid a contradiction

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In the recommendations of the Sub-Commission on the Systematics of Igneous Rocks of the International Union of Geological Sciences, in the volume edited by R.W. Le Maitre (2002), there is an evident contradiction in the definition of the dioritic and syenitic plutonic rocks.

According to Le Maitre (2002) the parameters used for the modal classification of the plutonic rocks are: Q, A, P, F and M, where:

Q = quartz, tridymite, cristobalite;

A = alkali feldspar, including orthoclase, microcline, perthite, anorthoclase, sanidine and **albitic plagioclase** (An_0 to An_5); **P = plagioclase** (An_5 to An_{100}) and scapolite;

F = feldspathoids including nepheline, leucite, kalsilite, analcime, sodalite, nosean, haüyne, cancrinite and pseudoleucite;

M = mafic and related minerals, e.g. mica, amphibole, pyroxene olivine, opaque minerals, accessory minerals (e.g. zircon, apatite, titanite), epidote, allanite, garnet, melilite, monticellite, primary carbonate.

When a rock is defined as felsic, e.g. $M < 90\%$, the modal classification is based on the QAPF diagram (Streckeisen, 1973, Figs. 1 and 2). To use the QAPF classification, the modal amounts of Q, A, P and F must be known and recalculated so that their sum is 100%.

When a rock plots in the following fields: 4, 9, 10, 13 and 14 (Fig. 1), the root names proposed by the classification are: diorite and gabbro (and anorthosite in field 10, with $M < 10\%$). A **Diorite** is defined when **plagioclase** = An_0 to An_{50} , whereas a **Gabbro** has **plagioclase** = An_{50} to An_{100} .

Therefore **a contradiction arises whenever the composition of the plagioclase = An_0 to An_5** . From the definition of A and P reported above, the albitic plagioclase should be part of the parameter A and, correspondingly, the parameter P would be = 0 (unless scapolite is present). Rocks containing albitic plagioclase (An_0 to An_5) would therefore fall inevitably in the fields closer to the vertex A of the QAPF diagram (e.g. the rocks that are supposed to fall in the field 4 would plot within the field 2, those in the fields 9 and 10 in field 6 and those in the fields 13 and 14 in field 11).

This contradiction does not help in resolving the confusion in the classification of rocks manifested in several publications in various scientific journals. Cases of dioritic rocks defined as syenites and vice versa are not uncommon. Examples of the first case are reported in: (a) Stähle et al. (1990), where pegmatites without K-feldspar and containing plagioclase = An_{07} - An_{11} are defined as mica syenites and nepheline syenites; (b) Stähle et al. (2001), where a dike consisting of hornblende and plagioclase = An_{08} - An_{13} is defined as hornblende syenite; (c) Schaltegger et al. (2015), where zircon, biotite, plagioclase-bearing pegmatites are defined as miaskitic nepheline syenite; the

plagioclase composition (An_{06} - An_{07}) of these samples is reported in Weiss et al. (2007). An example of the second case is reported in Yu et al. (2011) who describes albite diorite rocks for the Zhongjiu iron deposit, following the quite old quantitative mineralogical

Figure 1. QAPF diagram with field numbers, after Le Maitre (2002). Light grey color = Fields where both diorite and gabbro are root names: the dioritic and gabbroic rocks with plagioclase composition $An > 5\%$ plot here; Dark grey color = Fields where the supposed dioritic rocks (considering the erroneous definition: plagioclase = An_0 to An_{50}) will plot if plagioclase composition $An < 5\%$ (and no scapolite is present).

Figure 2. QAPF diagram with field names, after Le Maitre (2002). Light grey color = Fields where both diorite and gabbro are root names: the dioritic and gabbroic rocks with plagioclase composition $An > 5\%$ plot here; Dark grey color = Fields where the supposed dioritic rocks (considering the erroneous definition: plagioclase = An_0 to An_{50}) will plot if plagioclase composition $An < 5\%$ (and no scapolite is present).

classification of igneous rocks of Johannsen (1920), while these rocks in reality are syenites.

The suggestion proposed here is to amend the definition of the diorite root as follows:

A **Diorite** is defined when **plagioclase** = An_5 to An_{50} . This is also in accordance with the first definition of Streckeisen (1973), who only had place the limit between diorite and gabbro the

composition $An = 50$, without setting the lower limit for the diorite root, as already implicit in the definition of the parameter A. Alternatively, the classification of plutonic rocks based on the chemical composition, as proposed by Bellieni et al. (1995), would be recommended.

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